PowerWAVE ELMOD

Technical Specification

KOHLERPOWER
uninterruptible

DOCUMENT CONTROL

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TS_682_01	15/06/20	First Issue
TS_682_02	22/08/22	Updated comm ports, O/P breaker update, Spec changes

Useful Contacts

www.kohler-ups.co.uk	Kohler Uninterruptible Power Ltd. web site
ukservice.ups@kohler.com	Service department – booking service, fault reporting etc.
uktechnicalsupport.ups@kohler.com	Technical queries
uksales.ups@kohler.com	Hardware sales
ukservicesales.ups@kohler.com	Extended warranty agreements etc

POWERWAVE EL MOD UPS SYSTEM DESCRIPTION

The Power Pro EL Modular Series is an emergency lighting Inverter that can be configured between 4 – 24kVA with incremental steps of 4kVA power. Designed with high fault clearance capability and operation with high inrush light fittings The adaptability of the EL MOD system provides three modes of operation as standard and the ability to convert from single phase input to three phase input without modification.

Low MTTR (Mean Time to Repair) is achieved with all electronic components in modular format and complete front access.

Advanced design features

- 24 KVA Power Cabinet, built up of 4kVA Power Modules
- 1/1 & 3/1 Configuration via display
- Hot-Swap Power Module
- True Sine Wave Output
- Output Configurable to 3 Modes of Operation (Changeover / Inverter / Non-Maintained)
- No Break Load Transfer for use with Discharge Lamps
- Deep Discharge Protection
- Reverse Battery Polarity Protection
- Front Access for all Maintenance and Repair
- Each module automatically equally shares the input and output current, All Inverter modules share the batteries
- Battery Short Circuit Protection
- Battery discharge management, auto-transfer between floating and equal charging, temperature compensation
- Multiple User options RS232, RS485, dry contacts, TCP/IP Adapter for local and remote communication.
- Compliant to BS EN50171

OPTIONAL FEATURES

- Input/output Transformer
- Load Distribution Module
- 10min, 1 Hour & 3 Hour Test key Switch
- Internal Maintenance Bypass Switch
- DC Earth Leakage Protection
- High IP Rating
- Other voltage options

1 Specification

1.1 Power module

POWER MODULE	ELM-04
Capacity	4 kVA
Input / Output mode	Single phase input/output
Input PF	≥ 0.99
THDI (%)	≤ 3%
Overload ability	Comply to system overload requirement
Charging power	1600W
Weight (kg)	7 kg

1.2 System cabinet

SYSTEM CABINET	Single-phase Input	Three-phase Input
MAINS / BYPASS INPUT		
Input Mode	1-phase +N +E	3-phase +N +E
Input voltage	220V / 230V / 240V ±25%	380V / 400V / 415V ±25%
Input frequency	50Hz±10%, 60Hz±10%	
Input Current	26A ~ 156A (26A per fitted power module)	78A (12 kVA system) 156A (24 kVA system)
Power walk-in (Sec.)	60secs	
THDI (%)	< 3%	
Input PF	≥ 0.99	
DC INPUT		
Rated DC Input voltage	±240VDC	
DC Input voltage tolerance	±216V~±246VDC	
DC Input current	10A ~ 60A (10A per fitted power module)	30A (12 kVA system) 60A (24 kVA system)
BATTERY CHARGING		
Charging current limited	Yes	
Charging ability	12 hours (3 hours back up)	
Stability of charging voltage	±1%	
AC OUTPUT		
Maximum Power	4 kVA to 24 kVA in 4 kVA steps (1 to 6 Power modules fitted)	12 kVA (3 modules fitted) OR 24 kVA (6 modules fitted) only
Power factor	0.9	
Output voltage	220 / 230 / 240VAC	

SYSTEM CABINET	Single-phase Input	Three-phase Input
Output frequency	50 Hz / 60 Hz nominal	
Output frequency sync	Nominal ±4%; ±0.2% (on battery)	
Output current	19.2~ 115.2A (19.2A per fitted module)	57.6A (12 kVA system) 115.2A (24 kVA system)
Output voltage stability	±1%	
Output voltage recovering time	20ms (load 0~100% change)	
Overload ability	120% Continuous, 150% for 10mins, 175% for 1 min	
Transfer from mains to battery supply	0ms	
Transfer from bypass to inverter supply	<1ms	
Peak factor	3:1	
Waveform distortion	≤ 1% (linear load), ≤ 3%(non-linear load)	
Overall efficiency	≥ 93% (AC~AC), ≥ 98% (DC~AC)	
Load share precision	≤5%	
Output Short Circuit	3 x Output Current for 120ms	
ENVIRONMENTAL		
Ambient temperature	-25°C ~ 60°C	
Operating temperature	-5°C ~ 40°C	
Maximum operation altitude	≤ 1500m	
Relative humidity	≤ 95% non-condensing	
Protection degree	IP30	
Cooling	Fan-assisted air cooling (front entry / rear exhaust)	
Applicable safety standards	EN62040-1-1:2003 IEC60950-1:2001 EN50171	
Electromagnetic compatibility	EN62040-2:2006	
Acoustic noise	≤ 55 dBA	
Heat dissipation	Changeover mode: 120W (per power module) Inverter mode: 280W (per power module) Non-maintained mode: 120W (per power module)	
COMMUNICATIONS		
External Interface	RS232, RS485, 2 dry contact, TCP/IP adapter	
Display	LCD/LED	
MECHANICAL		
Cabinet dimensions (W x D x H)	510 x 850 x 1340 mm	
Cabinet weight	100kg cabinet + 7 kg for each power module (i.e. 107 kg with one power module up to 142 kg with six modules)	

POWERWAVE EL MOD

Frame 24kVA - 6 Module Rack

4kVA Module

24kVA Control Module

Display Measurement Readings

- Input Voltage L-N Per Phase
- Bypass Voltage L-N Per Phase
- Output Load Percentage Per Phase
- Output Voltage L-N Per Phase
- Output Voltage L-N for each module
- Output Current Per Phase
- Output Current for each module
- Output Frequency
- Positive Battery Voltage
- Negative Battery Voltage
- Positive Battery Charge Current
- Negative Battery Charge Current
- Positive Battery Discharge Current
- Negative Battery Discharge Current
- Battery Capacity %
- Battery Temperature

Display Alarms

- Mains Anomaly
- Bypass Anomaly
- Battery Anomaly
- Inverter Anomaly
- Phase Sequence Anomaly
- Pre Overload
- Over Load
- Heavy Load
- Output Short circuit
- Battery Supplying Load
- System Online
- Mains Restored
- Bypass Restored
- Battery Restored
- Inverter Restored
- Incoming Phases OK
- Operation Rejected
- Output Breaker Off
- Equalisation Charge
- Float Charge
- EPO Warning
- Communication Fault
- Fan Fault
- Module Fault

1.3 Functional description

1.3.1 Introduction

The PowerWAVE EL MOD is a modular Static Inverter (SI) comprising up to six, hot-swappable, 4kVA power modules. It produces a single phase output and can be configured to operate with either a single-phase or three-phase input supply.

Depending on the number of fitted power modules, the PowerWAVE EL MOD system can provide an output rated between 4kVA and 24kVA in 4kVA increments.

Each 4kVA module contains a rectifier, inverter and static switch power sections, as shown in Figure 1.1

This diagram shows that the power module is connected to the AC INPUT, DC INPUT and UPS OUTPUT power connections. These are all located on the back of the PowerWAVE EL MOD cabinet.

Note: The input and output power connections are not switched within the standard cabinet so suitable external power switches and protective devices must be provided as part of the cabinet installation – as described in the user manual.

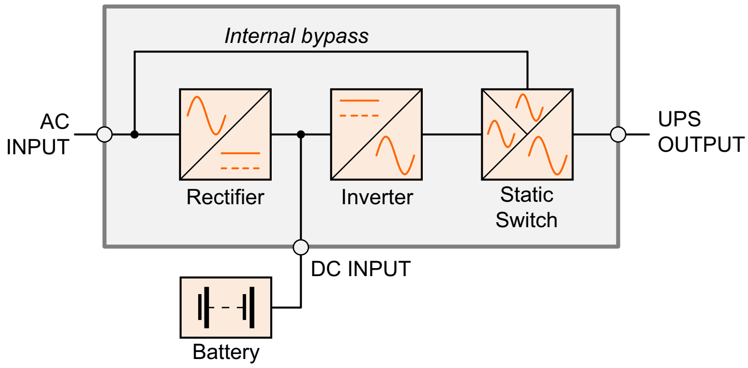

Figure 1.1 4kVA Module power sections

Rectifier

The PowerWAVE EL MOD employs a PWM-controlled booster rectifier using IGBT devices. This results in a high input power factor, approaching unity, together with low input current harmonics.

The rectifier is powered from the utility mains supply connected to the AC INPUT terminals and produces a well regulated DC voltage that is suitable for supplying the inverter and charging the batteries. The rectifier produces a dual-polarity output which is required by the inverter in order for it to generate a 'neutral-referenced' output waveform.

Note: The AC INPUT neutral must be permanently connected and unswitched.

Batteries

Batteries provide a reserve DC power supply for the inverter to allow it to continue to operate in the event of a mains supply failure – whereupon the rectifier will shut down. A number of battery blocks (typically 40) are connected in series to provide the terminal voltage required by the inverter. The mid-point of the battery string is connected to the AC INPUT neutral in order to provide the inverter with its necessary dual-polarity DC input – for this reason the battery string must contain an even number of cells.

Note: In practice the number of installed batteries depends on the battery capacity and the required battery back-up time.

The batteries will begin recharging from the rectifier immediately when the mains supply is restored following an outage.

Inverter

The PWM-controlled inverter uses the latest IGBT devices and DSP technology to convert its input DC voltage (provided by the rectifier and/or batteries) into a digitally controlled AC voltage, with fixed voltage and frequency. The inverter output directly supplies the emergency luminaires connected to the UPS OUTPUT terminals.

Static Switch

A solid-state static switch enables the UPS OUTPUT terminals to be connected to either the inverter or the internal bypass power source. The static switch will transfer the output between these two supply sources in a controlled manner depending on the selected operating mode, load demand and prevailing mains supply conditions.

1.3.2 Modes of operation

The PowerWAVE EL MOD can be configured to operate in one of three modes to suit the degree of supply integrity required for a particular lighting application.

Changeover mode

When operating in the 'changeover' mode:

- the rectifier is turned on to provide battery charging
- the inverter is turned on and operating on standby (off load)
- the bypass-side of the static switch is turned on to connect the UPS OUPUT to the AC INPUT via the internal bypass line.

If the utility supply fails, the static switch will transfer the UPS OUPUT to the inverter within 10ms. However, as the utility supply is in a failed state the rectifier is inoperative and the inverter will be powered solely from the batteries (see Figure 1.4).

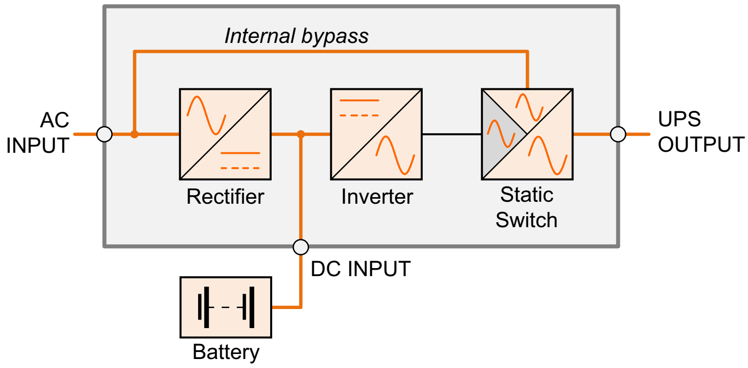

Figure 1.2 'Changeover' mode

Inverter mode

When operating in the 'inverter' mode:

- the rectifier is turned on to power the inverter and provide battery charging
- the inverter is turned on
- the inverter-side of the static switch is turned on to connect inverter to the UPS OUPUT.

The emergency luminaires are powered from the regulated inverter output.

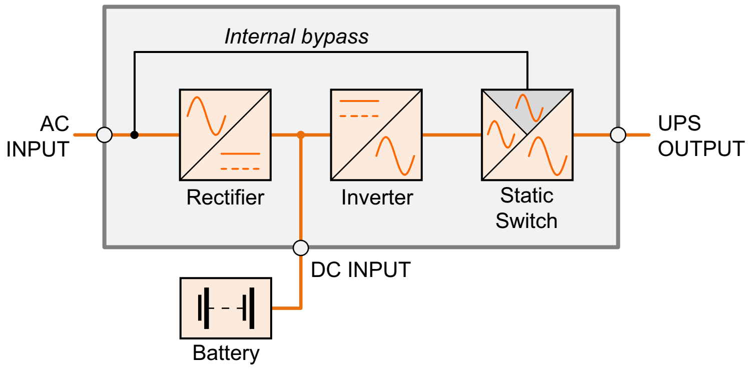

Figure 1.3 'Inverter' mode

On battery operation

If the mains supply fails, the rectifier turns off but the inverter will continue to operate from battery power until the batteries reach their end-of-discharge voltage; at which point the inverter will shut down and disconnect the UPS OUTPUT supply.

If the AC INPUT supply is restored before the batteries are fully discharged, the rectifier will turn on automatically to once again power the inverter and recharge the batteries.

The whole process of switching between rectifier and battery power is totally transparent to the emergency luminaires.

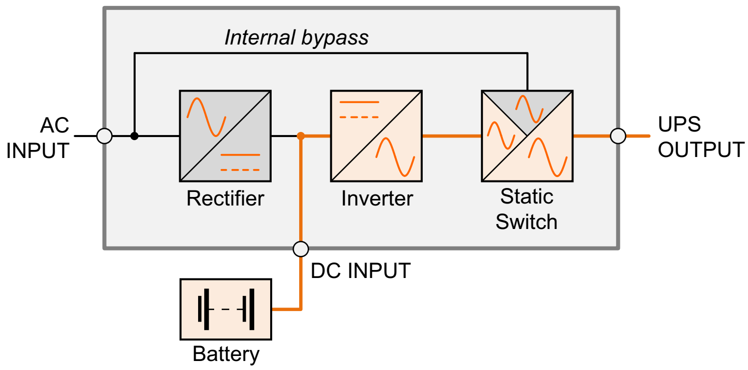

Figure 1.4 'On Battery'

Non-Maintained mode

In this operating mode the unit can be viewed as operating purely as a 'standby' power supply as the PowerWAVE EL MOD is not called upon to provide any UPS OUTPUT power under normal circumstances.

When the mains supply is available:

- the rectifier is turned on to power the inverter and provide battery charging
- the inverter is turned on
- both the inverter and bypass sides of the static switch are turned off, so the UPS OUTPUT is not live.

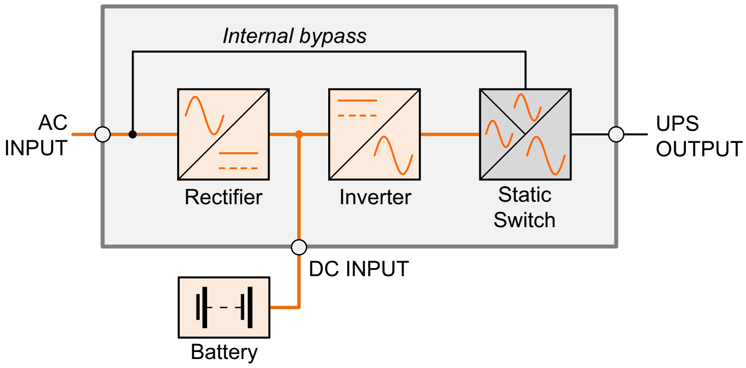

Figure 1.5 'Non-Maintained' mode

If the mains supply fails, the static switch immediately closes its inverter-side switch which connects the inverter to the UPS OUTPUT; however, as the utility supply is in a failed state the rectifier is inoperative and the unit immediately enters its 'on battery' operation (see Figure 1.4).

If the utility mains is restored before the batteries are fully discharged, the system will revert to its normal operating state; the rectifier will turn on to recharge the batteries but the static switch will once again turn off both 'sides' and effectively once more disconnect the UPS OUTPUT. That is, the PowerWAVE EL MOD will revert to its stand-by function.

Operating mode comparison

Mode	Efficiency	Summary
Changeover	98%	The lighting load is normally powered from the raw utility supply and will be subject to any supply aberrations. This mode of operation is recommended for loads that do not require a continuously regulated and processed power supply.
Inverter	93%	The lighting load is normally powered from a continuously regulated and processed power supply and protected from any supply aberrations present on the raw utility supply. Although it is less efficient to operate in this mode than the others, it is recommended for use with any load that is supply-sensitive.
Non-Maintained	93%	This mode is intended to be used in a 'stand-by' situation – for example to power an emergency lighting system that is required to turn on only when the main lighting system fails. Although the efficiency is shown as 93%, this is only applicable when the inverter is on line (providing load power). During normal operation the rectifier/inverter losses will be minimal (see specification).

In all three operating modes the system eventually operates from battery power when called upon; and the duration for which the PowerWAVE EL MOD is able to maintain the load supply from battery power depends on the installed battery capacity and the applied percentage load.

In some installations a standby generator can be used to provide an alternative AC INPUT supply following a utility mains failure. When used, the standby generator usually runs up automatically following the utility mains failure and is connected to the PowerWAVE EL MOD though some form of automatic input supply changeover switch.

Irrespective of whether or not a standby generator is used, battery sizing is an extremely important system design factor.

1.4 Installation planning (environmental & mechanical)

1.4.1 Environmental considerations

A certain amount of pre-planning will help provide a trouble-free installation process. You should consider the following guidelines when planning the installation location and operating environment.

1. The route to the installation location must allow the equipment to be transported in an upright position.
2. The floor at the proposed installation site and en-route from the off-loading point must be able to safely support the weight of the cabinet/battery equipment, plus fork lift or trolley jack during transit.
3. The cabinet requires sufficient front and rear clearance to enable cooling airflow, as described below.
4. All maintenance, servicing and user operation can be carried out from the front of the cabinet, but rear access is required for connecting the AC and DC power cables.
5. An ambient temperature of 20°C is necessary to achieve the recommended battery life span.
6. The cooling air entering the cabinet must not exceed +40°C.
7. The floor material should be non-flammable and strong enough to support the heavy load.
8. In summary, the system should be installed in a location where:
    a) Humidity (< 93%) and temperature is ideally 20°C.
    b) Fire protection standards are respected.
    c) Cabling can be performed easily.
    d) A minimum 600mm front accessibility is available for service or periodic maintenance.
    e) Adequate cooling air flow is available.
    f) The air conditioning system can provide a sufficient amount of air cooling to keep the room at, or below, the maximum desired temperature (where used).
    g) No dust or corrosive/explosive gases are present.
    h) The location is vibration free.

1.4.2 Clearances

Cooling air enters the front of the power modules and force ventilate through the cabinet rear.

a) You should provide a minimum of 600mm clearance at the front of the cabinet to allow the power module(s) to be removed/installed.
b) You should provide a minimum of 300mm at the rear of the cabinet and 700mm above the cabinet.
c) The cabinet does not require any side clearance for cooling purposes so it can be installed immediately adjacent to another cabinet, battery enclosure or wall; however rear access is necessary for cabling purposes.

The battery installation is bespoke, and specific access clearances will by specified by the battery installation designer.

The total width of the system hardware can range from 88mm, for a stand-alone UPS cabinet, up to 352mm where the maximum of three (optional) battery cabinets are attached to the UPS cabinet – only one battery cabinet shown in the diagram above.

The left hand diagrams show the ‘operating’ clearances necessary to provide adequate cooling. For maintenance, at least 800mm side access is required and, where necessary, the cables connected to the UPS should be made sufficiently long to allow the UPS to manoeuvred to a position where the clearances shown in the right hand diagrams are obtainable.

When the UPS is rack-mounted, a minimum of 200mm should be available between the rear of the UPS and the back of the rack cabinet to enable adequate ventilation and provide space for cabling. It is permissible to install the PW1000 1kVA model in a cabinet with a depth of 600mm, although this will only provide 195mm rear clearance rather than the desired 200mm shown in the above diagram.

The rack cabinet must have a ventilated door and a minimum clearance of 800mm must be provided at the front and rear of the cabinet to allow full UPS access for installation and maintenance.

1.5 Installation planning (cabling considerations)

1.5.1 General requirements

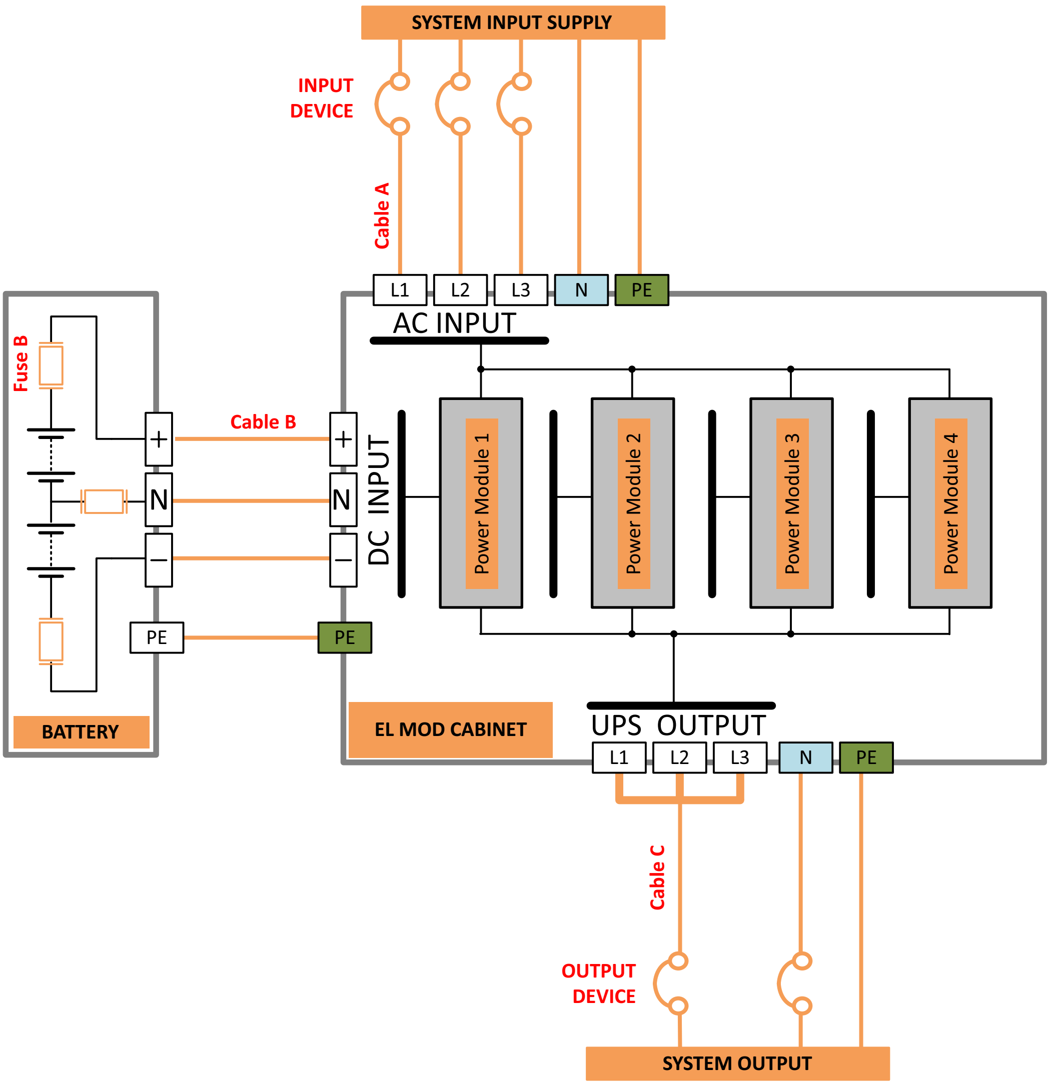

Figure 1.6 Power cabling connections and protection

It is the customer's responsibility to design and install the PowerWAVE EL MOD supply and distribution circuits, and provide all the external fuses, switchgear and cables required to connect the cabinet's AC INPUT, DC INPUT and UPS OUTPUT supplies. The information provided in this section should assist you in the planning and preparation of the power cabling.

As shown in Figure 1.6, the AC INPUT terminals should be connected to a utility mains LV-switchgear panel and protected by a circuit breaker or fused isolator. The protective device not only offers overload protection but also provides a means of disconnecting the mains supply from the PowerWAVE EL MOD, as there is no input supply switch fitted to the standard cabinet.

A fused battery isolator must be fitted inside the external battery cabinet – or immediately adjacent to the battery installation if a purpose-designed battery cabinet is not used. This requires a three-pole device, connected to the battery positive, negative, and mid-point (neutral), as shown. Kohler Uninterruptible Power Ltd. can supply a matching battery cabinet containing the necessary fuses and switchgear.

Similarly, the UPS OUTPUT terminals should be connected to the load equipment via a suitably protected load distribution panel. The recommended output circuit breakers are specified in the following table.

Output circuit breaker recommendation

Depending on the number of installed modules, we recommend that the EL loads are protected using the circuit breaker types specified in this table.

Number of Modules	System Rated Output Current	Output Device(s)						
		B4	B6	B10	B16	C10	C16	C20
1	15.6A	X						
2	31.2A	X	X	X				
3	46.8A	X	X	X	X	X		
4	62.4A	X	X	X	X	X		
5	78.0A	X	X	X	X	X	X	
6	93.9A	X	X	X	X	X	X	X

1.5.2 Inrush Current

Special Consideration should be taken when installing luminaires with very high inrush characteristics.

The Inrush Current of LED Luminaires is determined by the driver (s) and is not proportional to the luminaire wattage or running current, LED luminaire inrush currents can be as high as 400 times the running current for a very short period of time.

Further information regarding LED inrush currents can be found by accessing the “LIA Technical Statement LIA TS35” from the LIA website (www.thelia.org.uk).

The table below provides some details regarding the maximum recommended inrush currents for luminaires:

Number of Modules	Maximum Inrush Current
1	35A
2	70A
3	105A
4	140A
5	175A
6	210A

If higher inrush levels are expected Kohler Uninterruptible Power Ltd. can provide Inrush Current Limiter for LED lighting Drivers.

Rated at maximum 16A continuous power they can be installed within lighting distribution panels.